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5.—*Notes on the Physical Features of Belize.* By A. S. COCKBURN, Esq.

(Communicated by the COLONIAL OFFICE.)

ON a flying visit of a few weeks along the southern coast, about a month ago, I was afforded a hasty opportunity of examining the geological formation of a portion of that part of the colony. From the short time at my disposal I could only touch at a few spots between Point Hicacos (the proposed site of the new city Austinopolis) and the Carib village of Punta Gorda, of which I now propose to give a slight sketch in continuation of my former report.\*

I found the prevailing type to be still of the tertiary period, but consisting of a system of rocks more consolidated and crystalline than those bordering the River Belize, on which I lately had the honour to report.

The whole coast from Sihun to the Sarstoon, embracing an extent of 103 miles, is intersected by no less than 23 rivers and creeks, besides several lagoons or inland lakes, which bring down a great quantity of mud and silt into the Gulf of Honduras, and more or less affect the kays and banks within the circle of that great barrier-reef which fringes the gulf, and marks the boundary of the blue waters.

The range of mountains beginning at Sihun and running nearly parallel with the coast, clothed with verdure to their summits, seem to be formed on calcareous matter, and appear no farther than two miles from the shore; but there are others, veiled in mist, rising behind higher and higher, at right angles to the coast-ridge, in amphitheatral form, whose conical shapes proclaim them to be volcanic. These give a very picturesque appearance to the landscape, and the whole was quite a treat to one long confined to the everlasting mangrove-swamps and deleterious marshes of the Belize dead-level.

On entering the splendid harbour of the "Seven Hills Estate," the seven hills conspicuous in the distance, the little kays and islets rising out of the clear water like so many emerald gems, crowned with coconut-palms bowing their plummy branches like ostrich-feathers waving in the wind, formed quite a miniature archipelago. There is excellent anchorage all along, and wells of splendid water on several of the islets; and in the basins formed by the surrounding kays and reefs the sea is as placid as an inland lake, and many little harbours of refuge are naturally created, where vessels might ride in safety, perfectly protected from the raging of the elements.

The formation is regularly stratified, and consists of a compact indurated argillaceous limestone, deposited in laminæ or successive layers between their beds of very fine clay, like immense slabs of flagstone, dipping under the water at the coast, and extending several miles inland, originally horizontal, but now tilted and wavy, fractured and dislocated here and there, where the land has been uplifted into ridges and hillocks, the whole covered with a stratum of clayey loam of varying thickness, and overtopped in some places with a rich black mould arising from the decayed droppings of the primitive forest; in others superimposed by a layer of sand forming the pine and cahoon ridges.

In some places the shore is still a marshy swamp covered with mangrove-bush, tall rushes, reeds, and swamp-grass, which conceal the river-banks, and the rank vegetation extends down to the sea. In others, again, there are sandy beaches upon which the Caribs build their villages, and where the land slopes up gently inward, and the rivers run upon pebbles and clean brown sand; but the soil is comparatively sterile, as at Hicacos, where the sandy soil and broken ridges prevail up to the lagoon, some two or three miles in the interior.

At Punta Gorda the land rises abruptly in a sort of ledge five or six feet,

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\* See 'Proceedings,' vol. xii. p. 72.

and the beach is strewed with a shingle consisting of large fragments of coral, flint, and feldspathic rock, mixed with a coarse gravel-like capelli,—the pieces still rough and angular, and scarcely water-worn, as if brought by the waves from no great distance; and accordingly, on further examination, I found the ledge to consist of an out-crop of conglomerates, composed of the same sort of rocks stuck in a bed of clay, like a coarse pudding-stone, but comparatively soft.

In the immediate neighbourhood there is a little stream of limpid water, called "Tom Taylor's Creek." I do not know how far inland it runs; but I am told it joins a lake about two miles in the interior. I paddled a mile up this creek to the base of the small hills in the background, where I found the stratification more fully and clearly developed.

The stream runs upon a bed of the laminated limestone, and as the ridges are approached the layers become tilted and broken, and the jagged edges of each lamina project on either side and under the stream; the intervening seams of clay being washed away, the layers come out clear and clean, showing through the transparent water the nature of the deposits. At the point I reached it was tilted at an angle of  $10^{\circ}$ , the dip being north and south, and the strike east and west, as if the strata were dislocated in the line in which the stream now runs, purposely to make an opening for it. The passage, however, is not formed by the erosion of the water, but evidently by a concussion of nature of some considerable force, which lifted the land and elevated the hills long after the limestone had been formed and consolidated under the sea.

The rock is a compact marly limestone, with a little iron oxide, in laminae of from two-tenths of an inch to two inches thick, internally traversed by veins of calcareous spar. In other places it is met with in blocks or amorphous masses with distinct crystals aggregated together in amygdaloidal nodules and permeated with the carbonized remains of decomposed seaweeds and other vegetable matter. It is of a dirty white or greyish colour when first taken up, sometimes variegated with patches of pale pink, but bleaches white on exposure to the atmosphere. Some of the slabs, almost in course of transformation into a beautiful description of marble, would make excellent paving-stones for door-steps, &c.

At Seven Hills Estate the hills, nearly equidistant from each other, range off in a somewhat irregular line, bearing south-west from the coast, and are of the usual dome-shape peculiar to the calcareous formations; they are all about the same altitude (500 to 600 feet), and the valleys between them 1000 to 1400 broad. Two of the hills are rather elongated (saddle shape), and on the ridges the slabs or layers incline at an angle of  $70^{\circ}$  on either side along the anti-clinal angle, while on the apex of the domes they dip around the circumference, forming what geologists call the "*qua-qua angles*," all splintered and shattered into a thousand pieces. As partial denudation has taken place, the exposed portions have become bleached in the sun and air, and at a distance appear like fragments of broken china scattered over the surface. The valley is partially cultivated, and produces some of the most luxuriant sugar-canes I have ever seen (and I have travelled through the sugar-plantations of many of the West India Islands), some 16 feet long, by 6 and 8 inches in circumference, and in very thick stools. The soil is a thick layer of clay resting upon loam, soft and moist-cutting like cheese, and underlying a fine black mould washed down from the hills. As the washing will give a constant supply of the carbonates, the silicates, and the phosphates arising from the decomposition of the limestone, those valleys will remain always fertile, and will raton over and over again for years without becoming exhausted.

It does not appear that the laminated formation extends to the kays, for most of them near the mainland are composed of the mud, gravel, and sand brought down by the rivers, and which have become covered with the mangrove-bush and remain half submerged, as the "bouges" and the "drowned kays,"

&c.; while in others, more solid and higher out of water, these accumulations of silt and débris seem to form the foundation upon which the coral-insects have raised a superstructure. I have dug 10 feet deep on the island of Turneffe, at 200 yards from the sea, and found nothing but loose calcareous sand identical with the beach and the sea-bottom of the place; while Calabash Kay, not 500 feet distant on the east and nearer the barrier-reef, is bounded on the side next the reef by solid rocks of porite coral, meandrina, and honeycombs, &c., the channel between the two islands being deep and free of the coral-building polypifers.

Near the mainland the water is turbid, and the floor of the sea is covered with soft mud; and in some places, as at the mouth of the Manatee River, with coarse gravel and silicious sand, but more to seaward it is of white calcareous sand. At the estuary of Belize, within the bar, the dredge brings up nothing but mud mixed with ferruginous sand and dead fresh-water and marine, littoral and estuary, shells; but the farther you recede the clearer becomes the water, and the cleaner and whiter the sand, which consists generally of comminuted fragments of corals, shells, sponges, remains of crustacea, &c., in all degrees of fineness. The sand at Point Placentia, and some other places, is brown siliceous, consisting of fine particles of flint and granite, and in other places of mica, quartz, and other hypogene rocks; and the beach of several of the islets is covered with the remains of sea-eggs (sea-urchins, *echini*, and other *echinodermata*), and various species of shells of all colours, prettily mottled and variegated, some of them exceedingly minute and beautifully polished, as at Water Kay, &c. In others, again, sponges, sea-fans, pumice-stone, algæ, and other sea-weeds, are scattered about; while the conch and the star-fish, the lobster and the crab, and other *radiata*, *crustacea*, and *mollusca*, are seen through the transparent water quietly resting below, or browsing on the marine flora of the deep; and the whelk and the cockle enjoying the genial rays of the sun on the exposed rocks forming the "iron-bound coast;" immediately behind which is the deep perpendicular gulf covered over by the almost unfathomable dark-blue water of the ocean.

Some of the kays are round and oval, but the majority are more or less long and narrow, flat, and low, not unlike the "atolls" described by Darwin as appearing in the Pacific Ocean; but I am unable to state whether they are increasing or decreasing in area. Darwin says, "In those seas where circular coral-islands abound, there is a slow and continued sinking of the submarine mountains on which these masses of coral are laid, while in other areas of the South Sea where coral is found above the sea-level, and in inland situations and where there are no circular or barrier reefs, the land is on the rise." I believe these kays fluctuate in size and elevation, oscillating, alternately sinking and rising. At one time a portion is washed away by violent storms or the action of the current, and the area becomes seriously diminished; at another the tempest and the waves bring up a great quantity of sand, shells, and other débris, and the island retrieves itself, and, by the operations of the industrious untiring coral zoophytes, becomes renovated and enlarged. Though volcanoes are not far off, shocks of earthquakes are seldom felt in this alluvial bottom; but still they must have some subterranean influence, and the débris of the neighbouring volcanoes is brought down by the rivers, and pumice-stone is often seen floating about in the sea or resting on the beaches of the kays around.

St. George's Kay, about nine miles north-east from Belize, with a lagoon to leeward, and based in a crescent-shaped reef measuring 1113 yards in length by 630 in breadth, appears to have been sinking for some time. It was inundated by the hurricane of 1813, and since then it has suffered two similar catastrophes, in 1827 and 1864, and the sea on the last occasion divided it into three distinct parts. It recovered itself somewhat after the waters had sub-

sided; but still every tide cuts it very nearly across at the former divisions, and on both sides it is evidently fast washing away.

South Snake Kay, however, is an example of the gradual increase of a coral-  
island. Here the attentive observer may see clearly the palpable operations of the little tiny insects labouring hard at the construction of their stony habitations. The island is 98 miles s.s.w. of St. George's Kay, of an oval form, measuring 880 feet one way by 400 at the broadest part, and about 4 or 5 feet above the water-level, surrounded by a white, glittering, sandy beach, dry, destitute of the mangrove-swamp, and covered with vegetation and several full-grown coconut and other fruit trees, and frequented by the wild pigeons and other birds, who feed upon the fruit and nestle there in the breeding season.

At the margin of the vegetation is the stem of an old dead guana-tree, measuring 22 inches in circumference, the lower part of which is perforated with holes to about a foot upwards from the ground. If this was done by the Teredo worm, it shows that some time or other, after the tree had fully grown (how long ago it is impossible to tell), the land must have sunk that depth under the sea, and that since then the sea has receded or the land risen.

The guana lives to a great age, but this does not appear to have been very old when it was cut down; and I am not aware that it grows in the water, or affects swamps or marshy places. Be that as it may, there is the stump now, 4 feet from the edge of the water, a monument and a mark to answer the next visitor whose aspirations may lead him thither to interrogate nature in his researches after scientific truths. The first two feet from the stump towards the sea, all around the island, is covered with blocks of coral and a mass of drift-wood, with barnacles, dead sea-weeds, and other waifs and strays thrown up by the sea, and the other two feet to the water's edge is of fine white sand. The tides do not now reach this mass, and, should any storm arise, the sea would only drive the débris higher up, and cover it with sand, &c., making room for other accessions of drift. At present the 4-feet beach forms a circle round the island gently sloping towards the sea, and at about 15 to 20 feet from the shore, the minute *Lithodomi*, *Milleporæ*, *Meandrinæ*, *Astrææ*, and other lamelliform polypifera, are hard at work, in 2-fathom water, patiently and persistently building their mural escarpments and beautifully coloured coralline groves, which spread out into fans and ramify into trees, their varied and elegant forms mingling and blending together, and the ever tremulous water, clear as crystal, reflecting their splendid hues like so many flickering rainbows. On these structures reaching the surface, the little zoophytes leave them and descend to the bottom to secrete fresh matter, while the waves, or the current, or the tempest, will break off the fragile branches and waft them to the shore, thus continually adding to the *detritus* of the beach, and increasing the area of the island. Even now the rain, percolating through the mass, disengages carbonic acid, which, acting chemically on the lime and the silica, &c., cements the whole into a compact solid mass; and in a few years, provided no subsidence takes place in the mean time, vegetation will cover the place, and the island be permanently enlarged. This is Nature detected, as it were, in the very act of her mysterious elaborations.

Here we anchored in 4 fathoms water, at 100 yards from the shore, and the armed lead brought up fine white sand, consisting of triturated corals and shells. How long safe anchorage will continue at the same distance (the rock-forming architects always advancing seaward) future observations will show.

I cannot conclude this report without referring to an extraordinary display of the luminosity of the ocean which occurred while we were quietly anchored

in this little cove, the appearance of which was surprising and beautiful in the last degree. It was about 8 o'clock on the evening of the 21st of August, the sea was calm and smooth as a millpond, the night clear and serene, but the stars, though not dull, did not shine with any peculiar brightness. Presently, a smart breeze set in from seaward, and, being against the tide, a chopping little sea arose, and immediately our placid millpond became a fretful lake, spluttering and bubbling like a caldron of molten silver. Every ripple, every wavelet, was transformed into a flaming brush of sparkling phosphorescent light, and the spray fell on the deck and around the vessel in brilliant scintillations of liquid fire, producing a most magnificent effect! This continued for about two hours, when the scene changed. I fancy it requires a peculiar state of the atmosphere to form the display of this phenomenon, for it was not a dark night, neither was it a very clear one. The moon was absent, and in the horizon were gathering electric clouds, which gradually crept up to the meridian, slowly enveloping the heavens with a funereal pall of threatening aspect, and about 10 o'clock the whole firmament was overcast. The wind abated, the luminosity ceased, and the waters reflected only the blackness of the night in striking contrast with the former brilliancy; suddenly vivid flashes of lightning shot up to the zenith, and spread out in sheets like the aurora borealis. The peals of thunder reverberated above and below, till the vessel itself seemed to tremble on the face of the water.

This continued until midnight, when copious showers of rain succeeded, and drove me into the cabin.